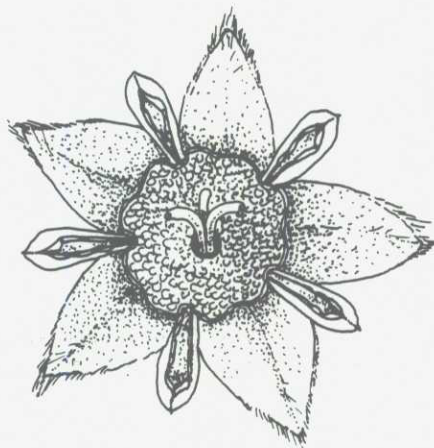
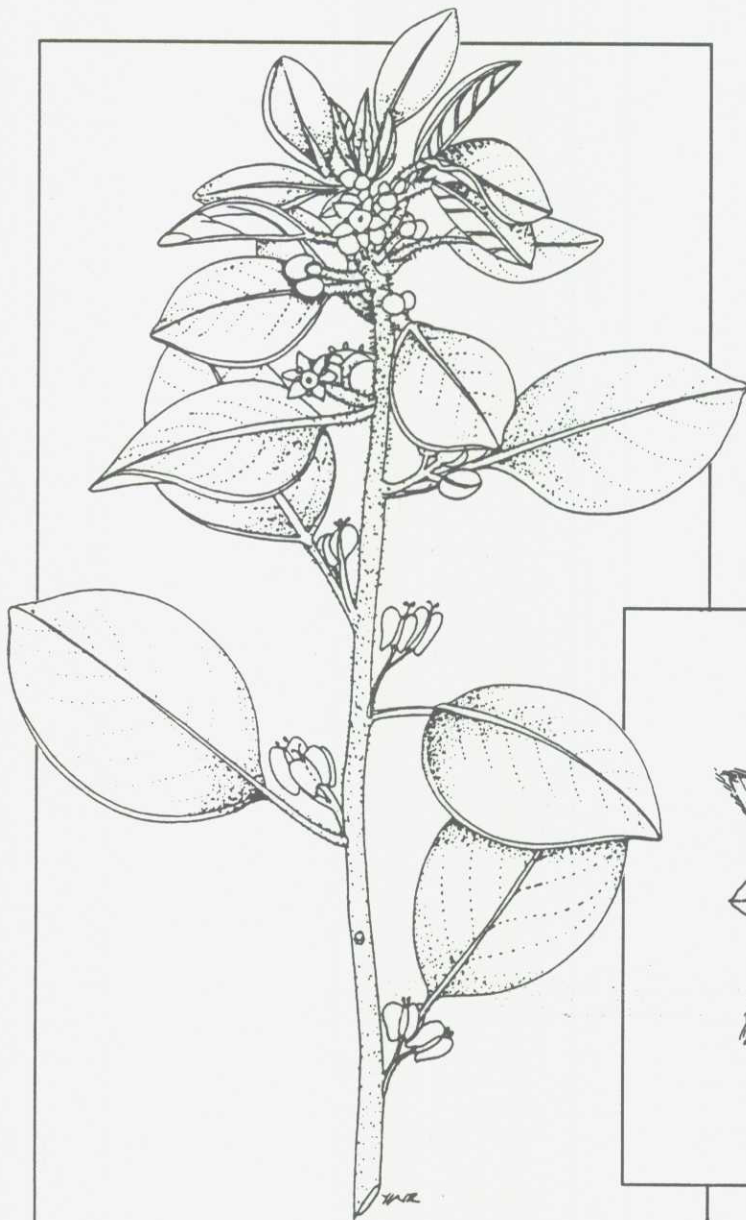


Recovery Plan for *Gouania Hillebrandii* (Rhamnaceae)

Department of the Interior
U. S. Fish & Wildlife Service



(bloom enlarged 11x actual size)

RECOVERY PLAN for GOUANIA HILLEBRANDII (RHAMNACEAE)

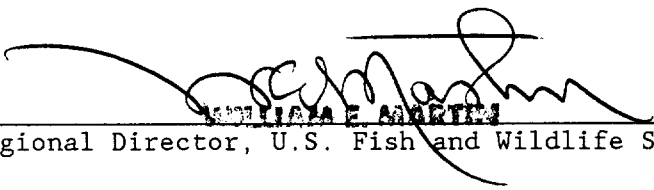
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Regional Director, U.S. Fish and Wildlife Service

JUL 16 1992

Date

THIS IS THE COMPLETED GOUANIA HILLEBRANDII (RHAMNACEAE) RECOVERY PLAN. IT HAS BEEN APPROVED BY THE U.S. FISH AND WILDLIFE SERVICE. IT DOES NOT NECESSARILY REPRESENT OFFICIAL POSITIONS OR APPROVAL OF COOPERATING AGENCIES AND DOES NOT NECESSARILY REPRESENT THE VIEWS OF ALL WHO PLAYED A ROLE IN PREPARING THIS PLAN. IT HAS BEEN PREPARED BY THE U.S. FISH AND WILDLIFE SERVICE TO DELINEATE REASONABLE ACTIONS WHICH ARE BELIEVED TO BE REQUIRED TO RECOVER AND/OR PROTECT THE SPECIES. THIS PLAN IS SUBJECT TO MODIFICATION AS DICTATED BY NEW FINDINGS, CHANGES IN SPECIES STATUS, AND COMPLETION OF TASKS DESCRIBED IN THE PLAN. GOALS AND OBJECTIVES WILL BE ATTAINED AND FUNDS EXPENDED CONTINGENT UPON APPROPRIATIONS, PRIORITIES, AND OTHER BUDGETARY CONSTRAINTS.

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5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
301/429-6403
or
1-800-582-3421

The fee for the Plan varies depending on the number of pages of the Plan.

ACKNOWLEDGMENTS: THE GOUANIA HILLEBRANDII (RHAMNACEAE) RECOVERY
PLAN WAS PREPARED BY THE HONOLULU OFFICE OF THE U.S. FISH AND
WILDLIFE SERVICE IN COOPERATION WITH WESLEY WONG AND ROBERT HOBODY
OF THE STATE OF HAWAII DIVISION OF FORESTRY AND WILDLIFE, AND WITH
R. ALAN HOLT OF THE NATURE CONSERVANCY OF HAWAII.

EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR Gouania hillebrandii

Current Status: This species is federally listed as endangered. Two subpopulations are known from the southwest region of West Maui. Historically, the species was found on Moloka'i, Lana'i, and East and West Maui in the Hawaiian Islands.

Habitat Requirements and Limiting Factors: Gouania inhabits lowland dry tropical ridges made up of weathered trachyte lava. Both of the known extant populations are on State lands. Trampling and grazing by cattle have had the greatest impact on the Pa'upa'u population. Infestation of Hibiscus snow scale, insect herbivory, competition from alien plants, and fire also threaten both populations.

Recovery Objective: Delisting

Recovery Criteria: Secure the 2 presently known subpopulations, each with at least 500 reproductive plants for down-listing; discover or establish 3 additional subpopulations and secure these, each with 500 reproductive plants for delisting.

Actions Needed:

1. Secure the habitat for the 2 existing subpopulations.
2. Identify insects and alien plants and develop control methods.
3. Conduct necessary management activities at existing sites.
4. Establish/discover 3 additional subpopulations.
5. Verify/determine recovery objectives.

Costs: (000's)

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5</u>	<u>Total</u>
1990	0.0	0.0	3.1	0.0	0.0	3.1
1991	0.0	6.0	3.1	4.0	0.0	13.1
1992	0.0	6.0	11.6	8.0	0.0	25.6
1993	0.0	20.0	5.6	8.0	0.0	33.6
1994	0.0	20.0	5.6	7.0	0.0	32.6
1995	0.0	0.0	13.3	30.0	12.0	55.3
1996	0.0	0.0	13.3	27.0	12.0	52.3
1997	0.0	0.0	7.3	6.0	9.0	22.3
1998	0.0	0.0	7.3	6.0	0.0	13.3
1999	0.0	0.0	7.3	6.0	0.0	13.3
2000	0.0	0.0	7.3	1.0	0.0	8.3
2001	0.0	0.0	7.3	1.0	0.0	8.3
2002	0.0	0.0	7.3	1.0	0.0	8.3
2003	0.0	0.0	7.3	1.0	0.0	8.3
2004	0.0	0.0	7.3	1.0	0.0	8.3
<u>Total</u>	0.0	52.0	114.0	107.0	33.0	306.0
<u>Cost</u>						

Date of Recovery: Delisting should be initiated in 2004

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION.....	1
Brief Overview.....	1
Description of the Species.....	4
Distribution and habitat.....	4
Population size and characteristics.....	9
Threats to population.....	10
Conservation efforts.....	12
II. RECOVERY.....	15
Objectives.....	15
Narrative.....	16
Literature Cited.....	26
III. IMPLEMENTATION SCHEDULE.....	27
IV. APPENDICES.....	33
APPENDIX A - Individuals Contacted During Technical Review.....	34
APPENDIX B - Agencies Contacted during Agency Review.....	36

LIST OF FIGURES

<u>Number</u>	<u>Page</u>
1. <u>Gouania hillebrandii</u>	3
2. Critical habitat of <u>Gouania hillebrandii</u> at Pa'upa'u, West Maui.....	7
3. Critical habitat of <u>Gouania hillebrandii</u> at Lihau, West Maui.....	8

GOUANIA HILLEBRANDII (RHAMNACEAE)

RECOVERY PLAN

PART I

INTRODUCTION

Brief Overview

Few plant communities in the United States have suffered greater rates of extinction than the lowland flora of Hawai'i. Clearing for subsistence agriculture by ancient Hawaiians and later for modern sugar and pineapple industries, browsing by feral and domestic livestock, competition from alien plants, and brush fires ignited purposefully or accidentally have eliminated native, lowland vegetation throughout the Hawaiian Islands. Surviving native taxa persist as scattered individuals in plant communities dominated by alien species or in rare, relict patches of indigenous plants.

The history of Gouania (Rhamnaceae, the Buckthorn Family), a genus of dryland shrubs and lianas, documents a general pattern of extinction of member species. Harold St. John (1969, p. 508), an authority on Gouania, wrote, "Most of the recent Hawaiian

botanists have never found a living specimen of Gouania, and of the 14 species only three have been found and collected since 1886." However, a recent revision of this genus, prepared for the Manual of the Flowering Plants of Hawai'i (Wagner et al. 1990), recognizes only three species, two of which are extant.

The best known surviving Gouania species is G. hillebrandii Oliver (Figure 1), the subject of this recovery plan. G. hillebrandii historically was found on Moloka'i, Lana'i, and East and West Maui. This shrub is now restricted to a few dry ridges in the southwest region of West Maui, on Maui Island, where it is threatened with browsing by domestic livestock, infestation of scale insects, insect herbivory, fire, and competition from alien plants. In 1973, an additional colony was discovered in Waiakuilani Gulch, Moloka'i (T. Pratt, 1987, pers. comm.) but the present status of this population is unknown.

G. hillebrandii was federally listed as endangered on November 9, 1984 (49 FR 44753); the effective date of the listing was December 10, 1984. This listing included the designation of critical habitat for the species.

FIG. 6. *Gouania Hillebrandi* Oliver, from Maui, Lahainaluna, St. John 25,609. *a*, Habit, $\times 1$; *b*, bud of perfect flower, $\times 15$; *c*, perfect flower, $\times 15$; *d*, petal, $\times 30$; *e*, stamen, $\times 30$; *f*, capsule, $\times 4$; *g*, seed, lateral view, $\times 5$; *h*, seed and hilum, apical view, $\times 5$. (*f*, *g*, *h* from St. John 26,723.)

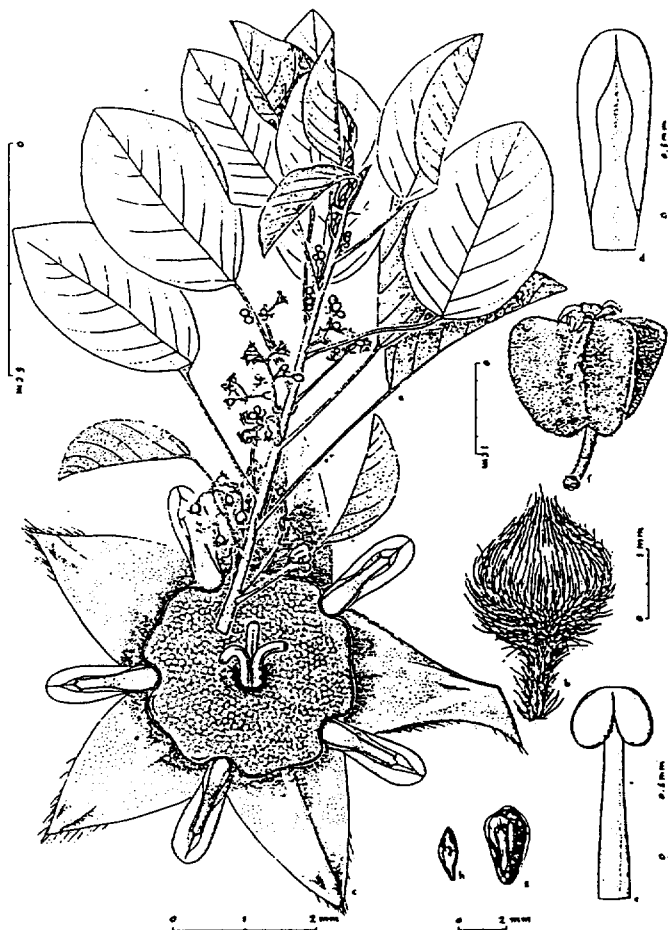


Figure 1. *Gouania hillebrandii* (page 520 from St. John 1969).

Description of the Species

Gouania hillebrandii is a shrub up to 6 feet tall, often comprised of a single unbranched or sparingly branched stem when less than 2 feet but becoming more branched and rounded with increased height. Branches are slender and covered with a rust or ash-colored fuzz. The dark green leaves are oval, 2 to 3 inches long by 1 inch wide. The small flowers are white and the tiny seeds are brown. This species is not known to reproduce vegetatively.

Distribution and habitat

The type locality of G. hillebrandii reads, "Maui! gulches of Kula and Lahaina." The Kula (East Maui) specimen was subsequently described as a new species, G. lydgatei St. John (St. John 1969), that has not been collected since and is perhaps extinct. All other specimens described or identified as G. hillebrandii originated from two subpopulations on West Maui (Figures 2 and 3).

(1) The Pa'upa'u subpopulation is on State lands administered by the Hawaii Department of Education under Executive Order No. 251. This Executive Order covers about 2,500 acres including the

Lahainaluna School campus and the forested land of Pana'ewa and Ku'ia extending to the summit of west Maui.

Located above Lahaina on the west facing slopes forming the south wall of Kahana Stream at between 1,100 feet and 1,600 feet, this subpopulation occupies roughly 15 acres within a designated critical habitat of about 50 acres on three contiguous ridges of weathered trachyte lava. Owing to trampling and browsing by cattle, much of the bedrock is exposed. Cattle have had the greatest impact on ridge top vegetation. On ridge crests G. hillebrandii is a rare component of a sparse, mixed shrub and tree community composed of both native and alien plants. A woodland of alien Grevillea robusta A. Cunn. (Proteaceae) occurs on ridge flanks and at higher elevations. Competition from G. robusta may be the reason for the absence of G. hillebrandii. Situated uphill from Lahainaluna School, this subpopulation has been known and collected for a long time.

(2) The Lihau subpopulation is on State lands managed by the Hawaii Department of Land and Natural Resources. This subpopulation occurs in 3 patches totaling roughly 10 acres within a designated critical habitat of about 60 acres on the west facing foothills at Lihau, between 800 feet and 1,700 feet in elevation. The small patch of plants at Pu'u Hipa is included in the Lihau subpopulation. In contrast to disturbed conditions at Pa'upa'u, the native plant community at Lihau has retained much of its

integrity, being composed largely of native shrubs and grasses. Ungulates are absent from the area, undoubtedly a reason why the vegetation shows relatively little disturbance. As at Pa'upa'u, G. hillebrandii is restricted to ridge crests of weathered trachyte at Lihau. Robert Hobdy and Rene Sylva of Maui discovered the subpopulation in 1979.

Though resident botanists have searched unsuccessfully on many nearby ridges for G. hillebrandii, the possibility exists that undiscovered subpopulations may still persist. The species can be detected only at relatively close range because it superficially resembles certain other shrubs with which it is associated.

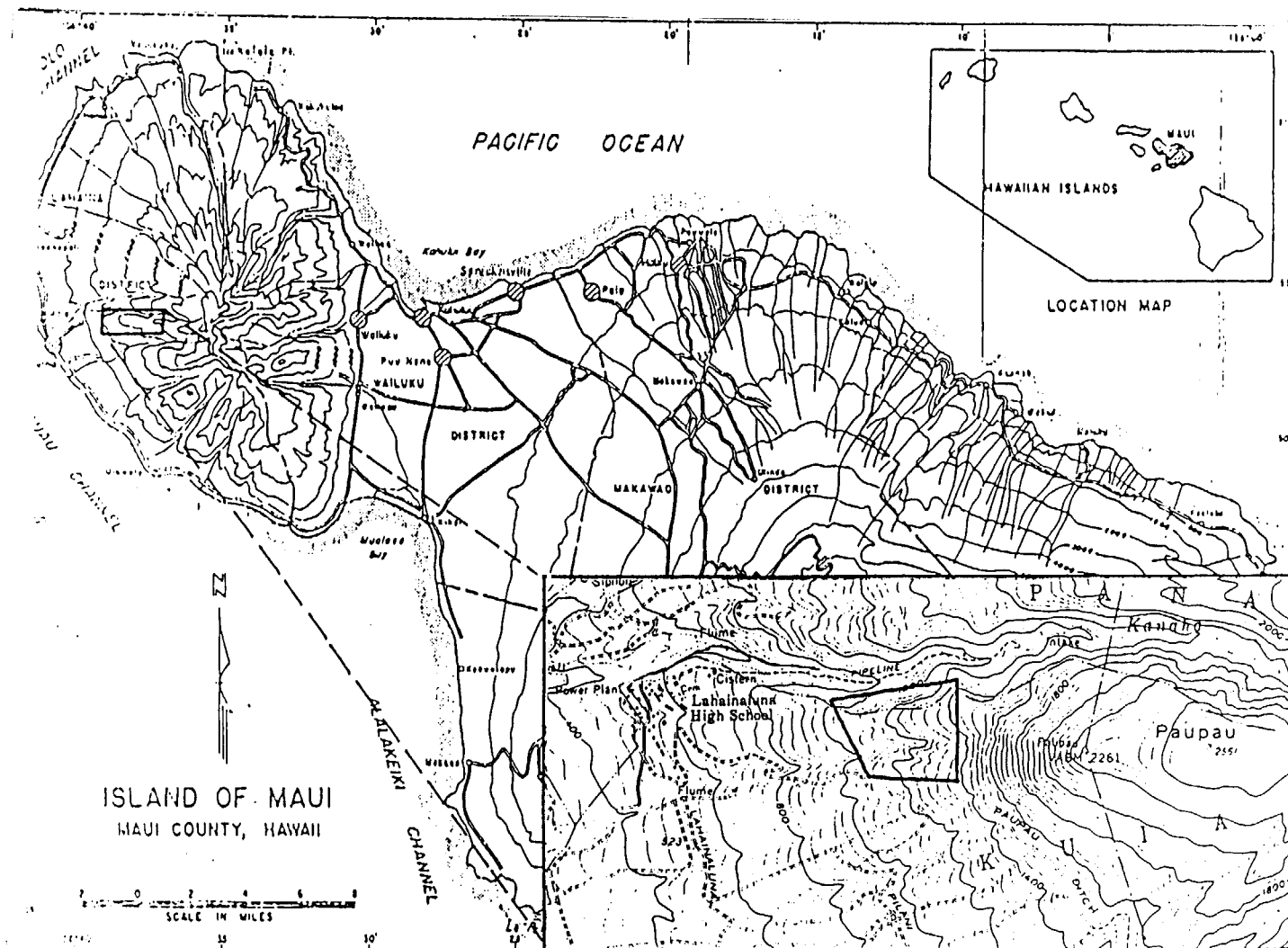


Figure 2. Critical habitat of Gouania hillebrandii at Pa'upa'u, West Maui.

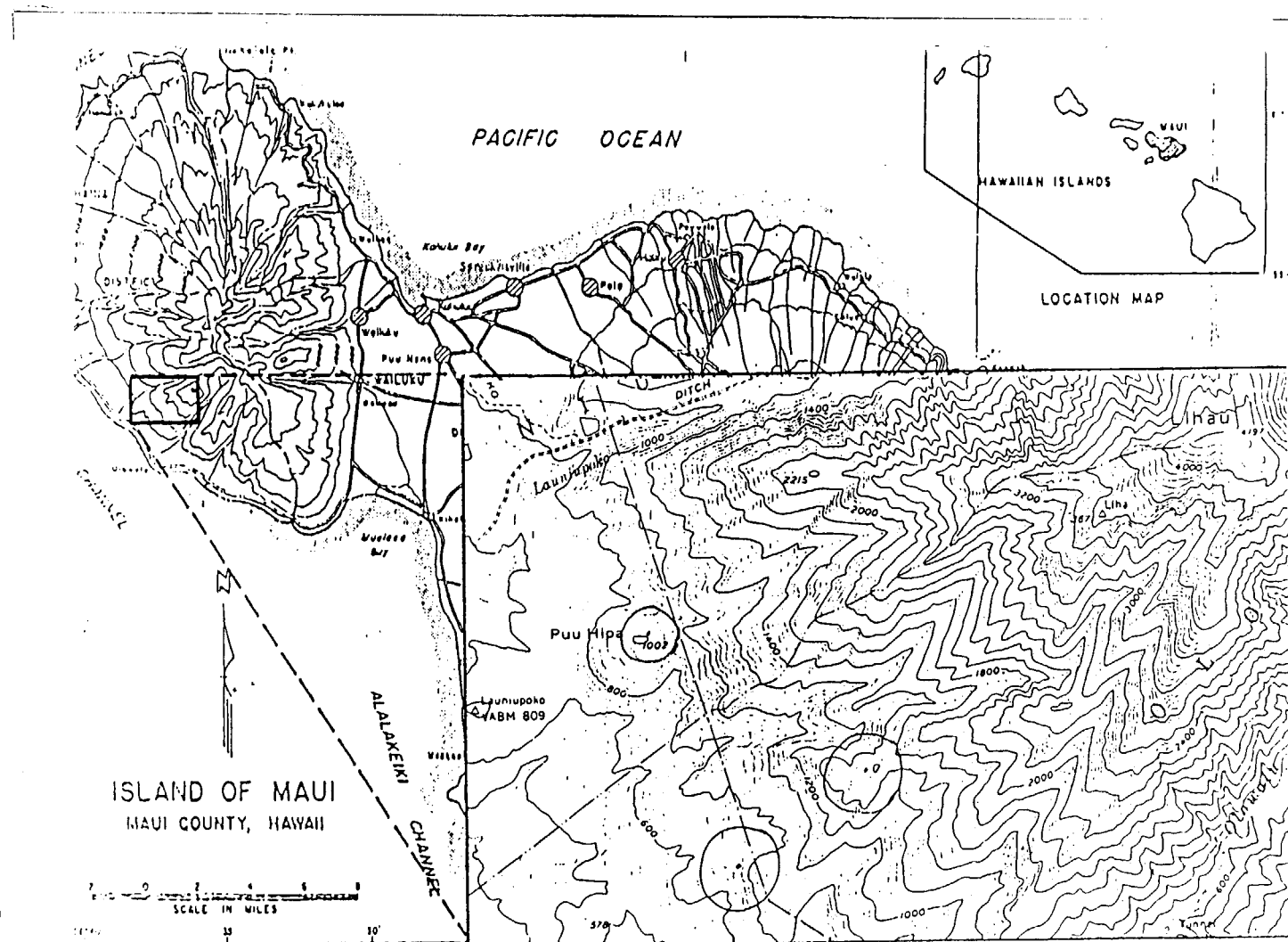


Figure 3. Critical habitat of Gouania hillebrandii at Lihau, West Maui.

Population size and characteristics

(1) Pa'upa'u. The size of this subpopulation has been estimated or counted on five occasions from 1955 to 1980. St. John first visited the site in December 1955 and G. hillebrandii appeared to comprise 25 percent of the shrub cover. On later visits in December 1965 and February 1966, St. John found the subpopulation much diminished and of reduced vigor (Holt 1981). Survey methods differed among observers, making it difficult to compare counts. In 1966, Cooley tallied 517 plants for three ridges. On November 10, 1980, Holt censused the same area as Cooley did in 1966 and estimated the subpopulation to be between 750 to 1,000 plants, with perhaps a third of these being seedlings less than 19 cm tall (Holt 1981). Gouania hillebrandii is capable of vigorous recruitment, as witnessed by Holt, who in 1980 estimated that one-third (30 percent) of the subpopulation was composed of shoots under 10 cm tall. The majority (65 percent) of the plants were between 15 cm to 1 m tall, with perhaps 40 individuals (2 percent) between 1.5 to 2 m (Holt 1981).

(2) Lihau. Only a single good estimate exists for the Lihau subpopulation: 950 to 1,100 plants in 1980 (Holt 1981). This subpopulation was composed mostly (85 percent) of mature plants over 30 cm and up to 1.5 m tall, but seedlings were also noticed

(Holt 1981). Changes in status of the Lihau subpopulation are unknown.

Threats to population

(1) Livestock. The Pa'upa'u critical habitat is State-owned land leased as cattle pasture. Cattle browse on G. hillebrandii, though the plant does not appear to be high quality forage. Cattle also alter G. hillebrandii habitat by trampling the vegetation and soil, creating areas of bare, compacted earth. Erosion is evident along cattle trails. Domestic goats are believed to have formerly caused similar problems, but neither domestic nor feral goats presently occur at either of the two localities.

(2) Hibiscus Snow Scale. In October 1980, Holt (1981) found at Pa'upa'u that the alien Hibiscus snow scale (Pinnaspis strachni) was affecting nearly all Gouania plants other than small seedlings. Dying above-ground parts of plants with heavy infestations were found. Only a few plants at Lihau were affected. No scale insects were found on G. hillebrandii plants at Pa'upa'u during a survey by D. Herbst, R. Hobdy, and T. Pratt in January 1985 (Herbst, 1987, pers. comm.).

(3) Insect herbivory. Herbarium specimens as early as 1955 show evidence of widespread damage to leaf margins by unidentified chewing insects. The signs of leaf-chewing insects are still present in both subpopulations but especially at Pa'upa'u (Holt 1981).

(4) Competition from alien plants. G. hillebrandii may face competition from alien plants, particularly at Pa'upa'u, where Grevillea robusta forms an open woodland along ridge flanks and occurs more sparingly as shrubs or low trees on ridge crests. G. hillebrandii will grow in open stands of Grevillea but is more abundant in full sun and exposed conditions. At Lihau, seedling establishment is quite low in areas of matted grasses, (native, and to a lesser extent, alien species).

(5) Fire. Both subpopulations of G. hillebrandii may be vulnerable to extirpation in the event of a brush fire. The natural role of wildfire in this ecosystem is not well understood but it is presumed that fire was never a major influence. Thus, man-caused fires are considered a threat to G. hillebrandii.

The several grass species that form dense mats among the G. hillebrandii shrubs could serve as fuel for fire during the dry summer months. Fire has not been reported at either site. The

slopes below the G. hillebrandii subpopulation at Pa'upa'u are so heavily grazed that insufficient fuel exists to carry a fire upslope. At Lihau, bare flows of ancient lava serve as a natural fire break between the Olowalu Dump and the grass and shrub community at higher elevations. Response of G. hillebrandii to fire is unknown. Considering the limited range of this endangered species, a single fire could have a potentially catastrophic effect on G. hillebrandii.

Conservation efforts

(1) Federal actions. The U.S. Fish and Wildlife Service listed G. hillebrandii as an endangered species in 1984 (November 9, 1984. Federal Register 49:44753). The decision was based principally on two status reports (Hobdy 1980, Holt 1981). Listing included critical habitat:

Hawai'i, Maui County, Maui Island, Lahaina District, two zones located as follows:

(a) Pa'upa'u Zone, Ahupua'a of Ku'ia. The following Universal Transverse Mercator (UTM) designations form the corners of the quadrangular Pa'upa'u habitat area: NW:0744123121; NE:0744723122; SW:0744223118. SE:0744723117.

(b) Lihau Zone, Ahupua'a of Ku'ia. This zone consists of three circular areas having radii of 0.1 mile on the western slopes of Lihau Mountain, one centered at Pu'u

Hipa (near UTM 0746823070), one at UTM 0747723063, and the third at UTM 0747223059.

(2) State of Hawai'i actions. The State of Hawai'i unofficially listed G. hillebrandii as an endangered species in 1979. Official State listing followed the federal listing in 1984, pursuant to Chapter 195D of the Hawaii Revised Statutes. However, the State had already taken the lead in recovery actions for G. hillebrandii by preparing a protection and management plan for the Pa'upa'u subpopulation (Hobdy 1980) and by establishing a Natural Area Reserve (approved by the Board of Land and Natural Resources and by the Governor) at Lihau that protects native shrub-land and other communities. Some of the Lihau subpopulation is presently included in and managed as Conservation District forest land under the jurisdiction of the State Division of Forestry and Wildlife. The Natural Area Reserve includes some of the critical habitat at the Lihau site but does not include the Pu'u Hipa area. However, the Natural Area Reserve does encompass suitable areas immediately outside the designated Lihau critical habitat site which might harbor additional G. hillebrandii or provide habitat for subpopulation expansion in the future. Designation as a Natural Area Reserve protects Lihau from development and land usage that might detrimentally affect the native plant and animal communities lying within the Natural Area Reserve boundaries. There are now opportunities to manage the natural communities to enhance

their integrity, although management recommendations for Lihau have not been identified in any plans at present (Hobdy 1980, Holt 1981).

(3) Cultivation. Attempts to grow G. hillebrandii from seed have not succeeded. Transplanted seedlings do grow well in cultivation and produce seed. The species has been grown at Foster Botanical Gardens in Wahiawa, at the Maui Zoo and Botanical Gardens, and at the Baseyard Nursery of the Maui Division of Forestry and Wildlife.

PART II

RECOVERY

Objectives

For the two existing subpopulations, once the cattle grazing and insect infestation are stopped/removed and the subpopulations have increased to at least 500 reproductive plants, G. hillebrandii could then be considered for down-listing to threatened status.

The target for delisting includes at least five subpopulations, each with a minimum 10-year average of at least 500 reproductive plants. The subpopulations should include an age structure with a large proportion of adults but still with a healthy number of seedlings with the actual percentages to be determined. Achieving these goals will allow for consideration to federally delist G. hillebrandii.

Narrative

1. Secure, restore, and manage known habitat such that it will support viable subpopulations of *G. hillebrandii*.

The habitat of *G. hillebrandii* is a dryland shrub community that has been largely destroyed through a variety of land uses. What remnants remain need to be given protective status. The currently known habitat for this species includes two areas of the Lahaina District on the island of Maui.

11. Pa'upa'u subpopulation.

The primary cause of habitat alteration at the Pa'upa'u site is browsing by cattle.

111. Secure habitat.

The critical habitat for *G. hillebrandii* needs to be protected under the Department of Land and Natural Resources plant sanctuary management program.

112. Manage habitat.

Once the habitat has been secured, various management tasks will be needed to protect and enhance the *G. hillebrandii* subpopulation at this site. These known management needs should be implemented.

1121. Terminate cattle grazing.

To manage the *G. hillebrandii* subpopulation effectively at this site, the grazing permit needs to be revoked for the portions of the parcel supporting this plant. Browsing and trampling by cattle are the principal sources of habitat disturbance at Pa'upa'u.

1122. Fence critical habitat at Pa'upa'u.

Protection for this area will require construction of a 1,500-foot long hog wire fence across the lower edge of the habitat at the 1,000-foot elevation. This would restrict grazing animals from this habitat as there are no domestic grazing practices nearby and no feral goats or pigs occur in the forest lands mauka (uphill) of this fence.

11221 Clear fence line and erect stock fence.

Selection and clearing of the fence line should take into account distribution of G. hillebrandii and habitat suitable for the species' expansion.

11222 Establish maintenance program for upkeep of fence.

Once construction of the fence is completed, it will be necessary to schedule periodic maintenance of the fence. Brushing may be required to keep the fence clear of vines. Cattle leaning into the fence may weaken it.

1123. Protect G. hillebrandii habitat from brush fire.

Pa'upa'u needs to be placed on priority fire protection. A site specific fire management plan, coordinated with the State Fire Management Plan for Maui County, is needed.

1124. Control incursion by alien plants.

Once the area is fenced, there may be an increase in the vigor and subsequent spread of the alien plants due to the reduction of grazing. Therefore, active steps will be crucial to control/remove the alien plants after the area is fenced.

11241 Schedule and complete initial eradication of noxious alien plants.

Control must begin as soon as possible after fencing is completed. Once cattle are removed from above the fence, the vegetation within will begin to recover. It would be most effective to prevent further spread of alien plants at that time. Thus basic research for control of alien plants (Tasks 221 and 222) needs to be completed shortly after cattle are removed.

11242 Schedule periodic weedings to prevent re-establishment of alien plants.

Periodic control efforts will be needed to prevent further incursion of alien plants.

Besides scheduling for the initial control, it will be necessary to schedule short, routine surveys of the critical habitat to determine effectiveness of alien plant control and to adjust scheduling of reapplication of control measures as needed.

1125. Control infestation of Hibiscus snow scale.

It is not known how well the plant will be able to withstand infestations of Hibiscus snow scale in the long term. However, it seems clear that control of scale insects will be necessary not only to reduce mortality of G. hillebrandii but also to ensure that the plants remain in good reproductive condition.

11251 Monitor scale populations and determine critical level of infestation.

Scale infestations should be monitored to determine: (1) seasonal occurrence of infestations, (2) levels at which control should be initiated, and (3) what natural controls of scale insects are already present. Low levels of scale infestation (as observed at Lihau) may be minimally harmful to G. hillebrandii plants and may allow the plants to develop their own defenses against these insects. Scale insects may be only a temporary or seasonal problem. Scale insects may already be subject to population control through specific predators or parasites, or through immunogenic response of the host plant.

11252 Apply control measures when and where necessary.

Control measures should be applied until the threat of the scale infestation on G. hillebrandii is removed. Periodic checking and reapplication of controls may be necessary.

113. Conduct baseline surveys of Pa'upa'u subpopulation, as needed.

Additional information on the ecological relationships of this subpopulation may be necessary for providing

optimal management. This additional information should be obtained, when needed.

114. Develop additional habitat management prescriptions, as needed.

If new information provides guidance to alter or add to existing habitat management needs, additional management strategies should be developed.

115. Monitor Pa'upa'u subpopulation.

The Pa'upa'u subpopulation should be monitored periodically to keep track of its status and response to management actions.

12. Lihau subpopulation.

The Lihau site is dominated by native plant communities. These areas need to be secured and protected from introduction of grazing animals and fire.

121. Secure habitat.

A major portion of habitat and some adjacent acreage has been included into the State Natural Area Reserve System. Additional occupied habitat (Pu'u Hipa), immediately outside the Natural Area Reserve, needs to be pursued for protective status.

122. Manage habitat.

Once the habitat has been secured, various management tasks will be needed to protect and enhance the G. hillebrandii subpopulations at this site. These known management needs should be implemented.

1221. Prevent cattle from grazing.

Neither cattle nor other livestock are presently a threat at Lihau. However, cattle do apparently wander up from lower elevations. The Lihau site should be checked periodically for signs of cattle. If domestic stock do become a problem, their owner should be notified and the animals removed.

1222. Protect G. hillebrandii habitat from brush fires.

Lihau needs to be placed on priority fire protection. Having a pre-planned strategy for protection from fire will be useful.

1223. Protect *G. hillebrandii* from herbivorous insects and competition from alien plants.

Once the habitat of *G. hillebrandii* has been secured, then the secondary threats of herbivorous insects and alien plants need to be addressed. (See tasks 11241-11242, 1125, and 11261-11263.)

123. Conduct baseline surveys of Lihau subpopulation habitat, as needed.

Additional information on the ecological relationships of this subpopulation may be necessary for providing optimal management. This additional information should be obtained, when needed.

124. Develop additional habitat management prescriptions, as needed.

If new information provides guidance to alter or add to existing habitat management needs, additional management strategies should be developed.

125. Monitor Lihau subpopulation.

The Lihau subpopulation should be monitored periodically to keep track of its status and response to management actions.

2. Conduct research for controlling limiting factors at *G. hillebrandii* sites.

Satisfactory methods for controlling limiting factors of *G. hillebrandii* are needed. This may require some investigation or research. Efforts are needed to determine how these management needs will be satisfied.

21. Determine appropriate methods for controlling insect infestation.

Effective control of scale insects is extremely important. The impact of chewing insects attacking leaves needs to be evaluated to determine if control is necessary.

211. Identify sources of chewing insect damage and control, if necessary.

Leaf damage by chewing insects should be investigated to learn which species of insects are responsible and what action, if any, should be taken against them.

212. Determine appropriate methods for controlling scale infestations.

An entomologist should be consulted who can recommend appropriate methods for controlling Hibiscus snow scale. Any plan to apply insecticides should take into consideration (1) that insecticides may eliminate predators or parasitoids already keeping the scale insect in check and (2) that insecticides may also poison native insects serving as pollinators or in other ways influencing the ecology of G. hillebrandii. It may be practical to spray only heavily infested plants.

22. Determine appropriate methods for controlling aggressive alien plants.

Effective control of aggressive alien plants is extremely difficult. Careful consideration is needed to determine what approaches can be successful in controlling such plants that threaten G. hillebrandii.

221. Determine which plant species pose a threat to the welfare of G. hillebrandii.

Before beginning an eradication program the site should first be surveyed to determine which species should receive priority for removal, based on their ability to take over G. hillebrandii habitat. Important criteria are: high reproductive capacity, dense canopy, aggressive root system, source of allelopathic suppression, and fuel source for fire.

222. Develop techniques which will control aggressive alien plants.

Control of alien noxious weeds can often be extremely difficult and requires careful planning to ensure that control efforts lead to the desired result. Considerable progress has been made in developing methods for removing weedy trees, shrubs, and vines from areas where their control is sought. Methods are often specific to individual species. Agencies most experienced in dealing with alien noxious plants are the State of Hawai'i Department of Natural Resources and Department of Agriculture, U.S. Forest Service, and the National Park Service. These agencies should be contacted for advice on control of alien noxious plant species in the critical habitat. A control plan should

be prepared for each species and should take into account methods and materials of control, objectives of control (complete elimination from enclosure vs. control localized to vicinity of G. hillebrandii plants), and control scheduling.

3. Search for new subpopulations of G. hillebrandii.

An important goal of this recovery plan is to locate all additional subpopulations of G. hillebrandii that may exist anywhere within the historical range. Recovery actions planned for the Pa'upa'u and Lihau subpopulations are expected to improve the chances of long term survival of those subpopulations. Sustaining additional new subpopulations would greatly enhance the species' survival by decreasing the risk of extinction. Protection of additional subpopulations would also preserve greater genetic diversity of the species and provide opportunities for further population increases and range expansion. If additional subpopulations are found, it will be necessary to append the recovery plan to include measures for protecting new subpopulations.

31. Initiate new surveys for G. hillebrandii.

A systematic search for new G. hillebrandii subpopulations should be planned and executed. Highest priority should be given to surveying trachyte exposures (as determined from geological maps) and dryland areas not previously explored by botanists including sites on Molokai from where this species has recently been reported. If found, new subpopulations should be mapped, censused, and threats evaluated.

32. Protect newly discovered G. hillebrandii habitat.

It is difficult beforehand to propose actions for protecting undiscovered subpopulations. Such actions should be done by persons knowledgeable of the newly-discovered subpopulations. Actions such as those under 112 and 122 may be needed. Appending the recovery plan to include additional recovery measures may be required.

4. Establish new subpopulations of G. hillebrandii, as deemed necessary.

If searches for new subpopulations of G. hillebrandii fail, then the establishment of new subpopulations should be attempted as a last resort to reach the goal of five subpopulations. Reestablishment planning is hampered by our ignorance of the species' requirements for soil type and propagation. Careful study and planning must precede the introduction of these plants to new areas.

41. Establish and maintain a propagule bank for G. hillebrandii.

Seeds should be collected from all portions of the remaining range of G. hillebrandii and maintained for potential future use in propagating plants. Attempts should be made to retain as much of the remaining genetic diversity as possible.

42. Study the requirements of G. hillebrandii necessary for propagation and introduction.

Studies should be designed to determine aspects of the life history and propagation of G. hillebrandii, as these relate to introduction of the species.

421. Study habitat requirements.

Though this plant appears to be restricted to outcroppings of trachyte, its edaphic requirements are poorly understood.

422. Locate suitable introduction sites.

Once the site requirements of the species are known, the next step will be to locate sites that would fulfill the plant's needs. Such sites should be mapped and classified on the basis of feasibility for management.

423. Determine appropriate propagation techniques.

This shrub is readily transplanted as a seedling, but seeds have not germinated in cultivation. Successful propagation techniques must be developed to ensure efficient cultivation of the plant and minimum impact on the reproduction of parental populations.

424. Determine appropriate introduction techniques.

Because no one has attempted to establish new subpopulations of this species, it will be necessary to discover how the introduction site should be prepared for G. hillebrandii, how the plants should be transplanted, and how they should be cared for once planted. This will require trial plantings.

425. Determine criteria for establishment.

Finally, it must be known what characteristics the new subpopulation should show to be considered established.

Follow-up studies should evaluate the newly established subpopulation in light of these criteria.

43. Introduce *G. hillebrandii* to new areas.

When sections 421-425 of the plan have been completed, then introduction can be initiated based on guidelines (425) generated by the study.

5. Determine/verify recovery objectives.

Research needs to be done on the population dynamics of *G. hillebrandii* to verify minimal population size needed for long term genetic stability and survival. Upon completion of this research, delisting objectives can be verified/determined.

51. Determine demographic unit(s).

Demographic units (demes) are localized populations of a species which make up a breeding or genetic unit. The demographic unit may be made up of a single site or several sites of occupied habitat.

Currently *G. hillebrandii* is theorized to have at least two demographic units: Pa'upa'u and Lihau. The Lihau deme is composed of plants occupying habitat in two different geographical areas that are separated by unsuitable habitat (i.e., Pu'u hipa cinder core and Lihau Ridge). The relation between the sites needs to be investigated. If all sites exchange genetic material frequently, then there is only one demographic unit. On the other hand, if none of the sites exchange genetic material at all or very infrequently, then there would be three demographic units. The delisting objective would need to be revised if either of the above cases are found to be true.

52. Determine minimal viable population level.

Minimal viable populations are determined for the demographic unit and not the individual site. The recovery objectives set minimal viable population levels for each of the two existing demes averaging (over a 10-year period) 500 reproductive plants each (i.e., Pa'upa'u and Lihau). The following additional information is needed to determine the minimal viable population: 1) departure from the random transmission of genes from generation to generation; 2) influence of overlapping generations; 3) departures from random dispersal of offspring; 4) departure of a 1:1 sex ratio; and 5) effects of fluctuations in population size from year to year. When the above information has been gathered, this data will be used to determine the minimum viable

population. Depending upon the outcome of this analysis the minimal number of reproducing plants for each deme may be increased or decreased.

53. Determine number of sites needed for each demographic unit.

A subpopulation whose plants are all found at a single site is very susceptible to extinction from random environmental and natural catastrophic events. Thus, within each demographic unit, the distribution of the plants should be such that a single fire would not destroy all of the plants of that deme. However, these "patches" of plants must be close enough to allow for re-invasion of sites where the plant was recently extirpated. Thus, data needs to be gathered on the probability of extinction due to catastrophic/environmentally caused events and used to determine the minimal number, configuration, and distribution of patches within the deme. This analysis is needed in order to ensure a high probability of persistence of the subpopulation.

54. Determine age structure of subpopulation needed for self-sustaining colony.

The subpopulation should include an age structure with a large proportion of adults but still with a healthy number of seedlings. Only limited observations have been made in the past, thus actual percentages for the different age classes can not be reliably predicted at this time. Upon completion of research to determine what age class distribution provides a long term stable population of the plant at a particular site, the delisting objective can be set for age class structure.

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PART III

IMPLEMENTATION SCHEDULE

The table that follows is a summary of scheduled actions and costs for this recovery program. It is a guide to meet the objectives of the Recovery Plan for Gouania hillebrandii, as elaborated upon in Part II, Action Narrative Section. This table indicates the priority in scheduling tasks to meet the objectives, which agencies are responsible to perform these tasks, a time-table for accomplishing these tasks, and the estimated costs to perform them. Implementing Part III is the action of the recovery plan, that when accomplished, will satisfy the prime objective. Initiation of these actions is subject to the availability of funds.

Priorities in Column 1 of the following implementation schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

Recovery Plan Implementation Schedule for *Gouania hillebrandii*

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES (\$1,000)					COMMENTS
						FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	
1	111	Secure habitat at Pa'upa'u	1	DLNR	0						Currently in progress, plant sanctuary status being implemented
1	1121	Terminate cattle grazing	1	DLNR	0						Effective June 1986
1	121	Secure habitat at Lihou	1	DLNR	0						Established as a Natural Area Preserve
		Costs Need 1			0	0	0	0	0	0	
2	211	Identify sources of chewing insect damage	2	FWS-RES* DLNR	6 0		3	3			
2	212	Develop methods for controlling scale insects	2	FWS-RES* DLNR	10 0				5	5	
2	221	Determine which alien plants are a threat	2	FWS-RES* DLNR	6 0		3	3			
2	222	Develop alien plant control techniques	3	FWS-RES* DLNR USFS	10 10 10				5 5 5	5 5 5	
		Costs Need 2			52	0	6	6	20	20	
		Pa'upa'u subpopulation									
2	11221	Erect fence	1	DLNR	3	3					Completed June 1986
2	11222	Maintain fence	Cont.	DLNR	14		1	1	1	1	
2	1123	Protect from fire	Cont.	DLNR	1						
2	11241	Eradicate noxious alien plants	2	FWS-FWE DLNR*	4 0						
2	11242	Prevent reestablishment of alien plants	Cont.	DLNR	8						

Recovery Plan Implementation Schedule for *Gouania hillebrandii*

PRIOR- ITY #	TASK #	TASK DESCRIPTION	TASK DURA- TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES (\$1,000)					COMMENTS
						FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	
2	11251	Monitor scale insects	3	FWS-FWE DLNR*	0 1.5			0.5	0.5	0.5	
2	11252	Apply control techniques	2	DLNR	4						
2	113	Conduct baseline surveys	1	FWS-FWE DLNR*	2 2			2 2			
2	114	Develop additional habitat management needs	Cont.	FWS-FWE DLNR*	12 0				1	1	
2	115	Monitor subpopula- tion	Cont.	DLNR	14		1	1	1	1	
Lihou subpopulation											
2	1221	Prevent cattle grazing	Cont.	DLNR	1.5	0.1	0.1	0.1	0.1	0.1	
2	1222	Protect from fire	Cont.	DLNR	1						
2	1223	Protect from herbi- vorous insects and competition with alien plants	Cont.	DLNR	16						
2	123	Conduct baseline surveys	1	FWS-FWE DLNR*	2 2			2 2			
2	124	Develop additional habitat management needs	Cont.	FWS-FWE DLNR*	0 12				1	1	
2	125	Monitor Lihou subpopulation	Cont.	FWS-FWE DLNR*	0 14		1	1	1	1	
		Costs Need 3			114	3.1	3.1	11.6	5.6	5.6	

Recovery Plan Implementation Schedule for *Gerrhonotus killebrandi*

PRIOR- ITY	TASK	TASK DESCRIPTION	TASK DURA- TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES (\$1,000)					COMMENTS
						FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	

Establish/discover three additional subpopulations											
3	31	Initiate surveys for new subpopulations	3	FWS-FWE DLNR*	6 6		2 2	2 2	2 2		
3	32	Protect newly discovered habitat	Cont.	FWS-FWE DLNR*	0 11						1
3	41	Establish a propagule bank	2	FWS-FWE* DLNR	6 6						3 3
3	421	Study habitat requirements	2	FWS-RES* DLNR	10 6						
3	422	Locate suitable introduction sites	2 2	FWS-FWE* DLNR	4 4			2 2	2 2		
3	423	Determine propa- gation techniques	2	FWS-RES* DLNR	10 10						
3	424	Determine introduc- tion techniques	2	FWS-RES* DLNR	10 0						
3	425	Determine criteria for reestablishment	1	FWS-RES* FWS-FWE DLNR	3 0 0						
3	43	Reintroduce to new areas	3	FWS-RES FWS-FWE* DLNR	0 9 6						
Costs Need 4					107	0	4	8	8	7	

Recovery Plan Implementation Schedule for *Gouania hillebrandii*

PRIOR- ITY #	TASK #	TASK DESCRIPTION	TASK DURA- TION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES (\$1,000)					COMMENTS
						FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	
		Verify/determine recovery objectives									
3	51	Verify demographic units	2	FWS-RES	6						
3	52	Verify minimal viable populations	3	FWS-RES	9						
3	53	Determine number of sites per deme	3	FWS-RES	9						
3	54	Determine optimum age structure	3	FWS-RES	9						
		Costs Need 5			33	0	0	0	0	0	
		Total Yearly Cost			306	3.1	13.1	25.6	33.6	32.6	

Cont. = The action will be implemented on an annual basis once the action is begun.

* = Lead Agency

FWS-FWE = U.S. Fish & Wildlife Service, Region 1 Fish & Wildlife Enhancement

FWS-RES = U.S. Fish & Wildlife Service, Region 8 Research

DLNR = State of Hawaii Department of Land and Natural Resources

USFS = U.S. Forest Service (Institute of Pacific Island Forestry)

TOTAL COST = Projected cost of task from start to task completion (for some tasks this will be annual cost

APPENDIX A

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